

Band structure of ^{68}Ge

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The nucleus ^{68}Ge has been studied to high spin for the first time. A thin target of ^{40}Ca was bombarded by a 134 MeV ^{32}S beam delivered by the ATLAS accelerator at ANL. Spectroscopy was performed with GAMMASPHERE (101 HPGe detectors) and the MICROBALL charged-particle detector array. By requiring events with four identified protons, an extremely clean data set was obtained for ^{68}Ge . Further enhancements were achieved by demanding that the total detected energy (particles plus γ rays) was appropriate for the 4p channel.

The level scheme of ^{68}Ge is very complex, which reflects the interplay of many different excitation modes in this nucleus. Nevertheless, there is some simplification above spin $16\hbar$ where we have identified four rotational bands that appear to terminate near spin $26\hbar$ and also a weakly-populated superdeformed band. In cranked Nilsson-Strutinsky calculations, there are four energetically favored high-spin configurations within the valence space outside the ^{56}Ni core which involve various numbers of $g_{9/2}$ excitations, namely: proton configurations with $I_{max}^{\pi} = 9^{-}$, 12^{+} , and neutrons with $I_{max}^{\pi} = 14^{+}$, and 16^{-} . These give rise to bands terminations of 23^{-} , 25^{+} , 26^{+} and 28^{-} which correspond

precisely with the four terminating bands observed experimentally. The superdeformed band has a configuration in which the core has been broken and two protons are promoted from the $f_{7/2}$ to the $g_{9/2}$ orbital.

The structure of ^{68}Ge sheds an interesting light on the generation of spin in the atomic nucleus and the extent of the region of high-spin deformation in nuclei near ^{56}Ni . Highly-deformed and superdeformed rotational bands have recently been identified in a number of proton-rich Ni, Cu, and Zn isotopes. These collective bands are observed in the $I \approx 10\text{--}30\hbar$ spin range and are often strongly populated (10–50% of the channel intensity) in high-spin fusion-evaporation reactions. This pattern arises because of the limited spin available from the small number of valence particles outside ^{56}Ni , making deformed bands built on core excitations the preferred mode of angular momentum generation at relatively modest spins. In ^{68}Ge , the valence spin content is considerably larger and the core-excited rotational bands do not become energetically favored until the highest accessible spins. This leads to both the observation of fewer such deformed bands and the weak population of the superdeformed band which is observed.